Journal of Anatomical Sciences

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J Anat Sci 10 (1)

Radiological Morphometry of Adult Clavicle in Rivers State

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ABSTRACT
This work was carried out to determine the average length and mid shaft diameter of the clavicle; to determine the correlation between the Clavicular length and mid shaft diameter of the clavicle on both right and left sides of the clavicle of adults in Rivers State. This work also seeks to establish a formulae for determining the right clavicular length using the left clavicular length and to evaluate if there are sexual or ethnic variations in these parameters. 400 normal Posterior anterior chest radiographs of adult Nigerians in Rivers state between the age range of 18 and 85 years were used for this study. Two hundred and eleven (211) males and one hundred and eighty nine (189) females respectively. The mean right and left clavicular length for males were 15.44±1.05cm and 15.75±1.02cm while, for females, it was 14.45±1.01cm and 14.79±1.13cm respectively. It was observed that the males had a significantly higher clavicular length than the females ($p<0.05$). The mean of the right and left mid shaft diameter of the clavicle for males was 1.17±0.15cm and 1.186±0.16cm, while for females, it was 0.99±0.13cm and 1.00cm±0.14 respectively. It was observed that the mean of the mid shaft diameter of the clavicle for male was significantly higher than that of the females ($p<0.05$). It was observed that the left clavicle was longer than the right clavicle for both males and females. It was also observed that, there were ethnic differences in these parameters. This study also observed that there was a strong positive correlation between right clavicular length and left clavicular length for males ($p<0.05$). This research has provided a baseline data for the Clavicular length and mid shaft diameter of the clavicle in Rivers state. It has also provided a formulae for estimation of the right clavicular length from the left clavicular length. It will be useful to the anatomist, radiologist, the surgeon, forensic scientist and biological anthropologist.

Key words: Clavicle, morphometry, Radiographs, Rivers State.

INTRODUCTION
The application of radiographs as a useful tool in sex assessment had earlier been reported[1]. The most common form of radiographic anatomy is studied on radiographs[2]. The image is taken either as a —PA (posteroanterior) or as an —AP (anteroposterior), depending on the direction of the X-ray beam. The projection is usually marked on the film[3,4]. The clavicle is a S-shaped bone[5] . It is also called the collar bone[6]. The clavicle is longer and its curvatures are more pronounced in the male[7]. The clavicle lies almost horizontally between the sternoclavicular and the acromioclavicular joints. The subclavian vessels and the trunks of the brachial plexus pass behind the medial third of the clavicle [8,9,10]. Udoaka and Nwokediuko[11] worked on the mean thickness of mid-clavicles for males and females of the Southern Nigeria. She observed sexual dimorphism in the thickness.

The anthropometry of the clavicle has been of interest of the study to several researchers[12,13,14,15]. The parts of the clavicle used were the length, mid shaft diameter and circumference, sternal head length, acromial head length and the medial and lateral angles. Racial differences have been observed by these early researchers in the clavicular measurements and reference values have been set for some races. Terry[16] studied the white and black Americans in 1932, a review of his values was done 40 years after by Singh in 1972 on the same ethnic Americans. The values of Singh were slightly different from those of [16]but not significant. Terry[16] had noted that in male and female American Negroes and in male American whites, the left bone was longer than the right but not statistically significant. He also observed that the clavicles of American negroes were longer than those of the American whites. Oliver[17] also studied the length of the clavicle in French people and observed that in an individual, the left clavicle was usually longer than the right. He pointed out that the length of the clavicle was not the same even in closely related racial groups, the average length of the bone was different in different races. Parson[12] had also set standards for the English. Other studies done in India by[18,19] also noted that in various zones of India, the length of the clavicles of the Northwest zone of Chandigraph were longer than the Amritsar and the Varansi zones. All the workers agreed that female clavicles were significantly shorter by about 10% than those of the males ($P<0.005$). The length of the adult left clavicle was always more than

that of the right side, this was attributed to the use of the right hand in right handed individuals, the curve of the right clavicle in adults becomes greater than that of the left side which leads to a shorter right bone as compared to the left, this difference was however not statistically significant (P>0.05). In all these studies, the skeletal clavicle was used. Anthropometric studies of the clavicles using radiographs have also been done. McGraw et al.[20] found out in their measurement of the length of the clavicle on chest radiographs in children that females achieved 80% of their clavicular length by the age of 9 years while that of the boys was at 12 years, they therefore attributed the longer lengths in adult males to this finding. Udoaka and Nwokediuko[11] worked on clavicles of Southern Nigerians using posterior anterior radiographs.

Despite the anthropological relevance of knowledge of morphometry of the Clavicle using Posterior-anterior radiographs of adults in Rivers State, there is scarcity of literature on the morphometry of the clavicle. This is the driving force behind this research. This work is carried out to determine the average length and mid Shaft diameter of the clavicle; to determine the correlation between the Clavicular length and Mid Shaft diameter on both right and left sides of the clavicle and to establish a formulae for determining the right clavicular length using the left clavicular length. This work also seeks to determine if there are sexual or ethnic variations in these parameters.

MATERIALS AND METHODS

400 normal Posterior anterior chest radiographs of adult Nigerians in Rivers state between the age range of 18 and 85 years were used for this study. Two hundred and eleven (211) males and one hundred and eighty nine (189) females. The location where this study was carried out were: University of Port Harcourt Teaching Hospital, Braithwaite Memorial Specialist Hospital in Port Harcourt and Military hospital in Port Harcourt. The radiographs were placed on a Viewing box and a Meter rule, was used to measure the parameters.

***Length of Clavicle**:* The maximum length of each clavicle was measured in centimetres (cm) from sternal end to acromial end using a rule.

Mid- shaft Thickness or diameter of Clavicle: This was carried out By bisecting the entire length of the clavicles using compass and measuring the thickness (superior to inferior border) of the clavicle at that level in centimetre (cm) using ruler.

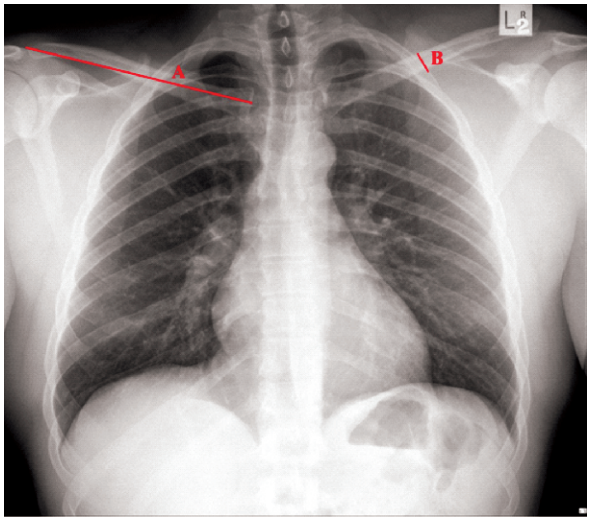

Figure1: showing the measurement of A.- clavicular length, B.- Clavicular width

All measurements were in centimeters for each parameter. The data on the measured parameters were analysed using the Z-test to determine the sex differences and ($p<0.05$) was taken as being statistically significant. A correlation study was carried out between the right and left Clavicular lengths for males and females. It was also carried out between the right mid shaft diameter and left mid shaft diameter of males. A regression analysis was also carried out to estimate the right clavicular length from left clavicular length and right mid shaft diameter from left clavicular mid shaft diameter for males.

RESULTS

The result of the mean, standard deviation, minimum and maximum values of all the measured parameters for males and females are shown in tables 4.1, 4.2 and 4.3 respectively. The mean right and left clavicular length for males were 15.44±1.05cm and 15.75±1.02cm while, for females, it was 14.45±1.01cm and 14.79±1.13cm respectively. It was observed that the males had a significantly higher clavicular length

than the females ($p<0.05$). The mean of the right and left clavicular Mid shaft diameter for males were 1.17±0.15cm and 1.186±0.16cm, while for females, it was 0.99±0.13cm and 1.00cm±0.14 for the right and left clavicular mid shaft diameter respectively. It was observed that the mean of the clavicular mid shaft diameter for male was significantly higher than that of the females ($p<0.05$). Table 4. shows comparison between the parameters in previous study and present study. It was observed that, there were ethnic differences in these parameters. Table 5: shows linear regression equation predicting right clavicular length from left clavicular length and right clavicular mid shaft diameter from left mid shaft diameter for males.

Figure 2 shows a Pearson correlation of right clavicular length (RCL) and left clavicular length (LCL) of female subjects. It was observed that there was a positive correlation between right clavicular length and left clavicular length for females ($p<0.05$). Figure 3 shows a Pearson correlation of right clavicular mid shaft diameter and left clavicular mid shaft diameter for males. It was observed that there was a strong positive correlation ($p<0.05$). Figure 4 shows a Pearson correlation of right clavicular length and left clavicular length for males. It was also observed that there was a strong positive correlation ($p<0.05$).

Table 1: mean, standard deviation, minimum and maximum values of measured parameters for males.

Variable	Sample size	Mean ± StDev	Minimum	Maximum
RCL(cm)	211	15.44 ± 1.05	12.20	18.60
LCL(cm)	211	15.74 ± 1.02	13.10	18.20
RMSD(cm)	211	1.17 ± 0.15	0.80	1.60
LMSD(cm)	211	1.186 ± 0.16	0.90	1.60
AGE	211	37.42 ± 12.64	18.00	80.00

KEYS: RCL=Right clavicular length, LCL=Left clavicular length, RMSD= Right Mid shaft diameter, LMSD=Left Mid shaft diameter.

Table 2: Mean, standard deviation, minimum and maximum values of measured parameters for females

Variable	Mean	± StDev	Minimum		Maximum
RCL(cm)	14.45	±	1.01	10.60	17.70
LCL(cm)	14.79	±	1.13	10.10	19.90
RMSD(cm)	0.99	±	0.13	0.60	1.50
LMSD (cm)	1.00	±	0.14	0.60	1.50
AGE	36.49	±	13.95	18.00	85.00

KEYS: RCL=Right clavicular length, LCL=Left clavicular length, RCW= Right clavicular width, LCW=Left clavicular width.

Table 3: z-test showing significant difference of measured variables of chest radiographs between males and females

VARIABLE	MALE mean±SD N=211	FEMALE mean±SD N=189	Z-VALUE CALCULATED	P-VALUE
RCL(cm)	15.44±1.05	14.45±1.01	9.60	P<0.05
LCL(cm)	15.75±1.02	14.79±1.13	8.90	P<0.05
LMSD(cm)	1.17±0.15	1.02±0.44	4.43	P<0.05

KEYS: RCL=Right clavicular length, LCL=Left clavicular length, LMSD=Left Mid shaft diameter.

Table 4: comparison of parameters between previous study and present study.

Researcher	Ethnic group	Parameter	males	Females
Parsons[12]	English	LCL	154mm	139mm
Oliver[17]	French	LCL	155.00mm	138.70mm
Jit and Singh[21]	India(Amntsar	LCL	147.59	129.80mm
Udoaka and Nwokediuko[11]	Southern Nigeria	LCL	15.28±1.3cm	14.50±0.5cm
		MSD	2.01±0.3cm	1.48±0.37cm
Present study	Rivers State	RCL	15.44±1.05 cm	14.45±1.01cm
		LMSD	1.17±0.15cm	1.02±0.44cm

KEYS: RCL=Right clavicular length, LCL=Left clavicular length, RCW= Right clavicular width, LMSD=Left Mid Shaft Diameter P <0.05

Table 5: linear regression equation predicting right clavicular length from left clavicular length and mid shaft diameter from left mid shaft diameter for male.

Variable	Regression equation
Male left clavicular length	The regression equation is RCL(cm) = 3.32 + 0.769 LCL(cm)
Male left Mid shaft diameter	The regression equation is RMSD(cm) = 0.367 + 0.677 LMSD(cm)

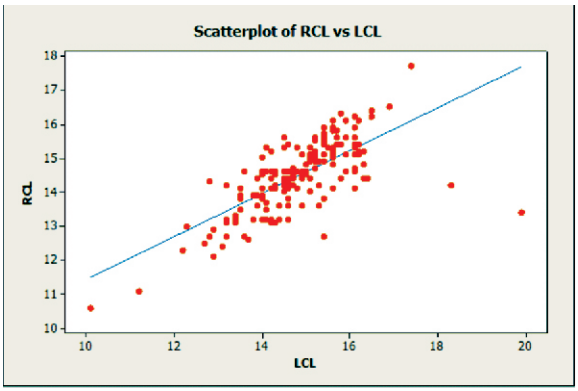

Figure 2: pearson correlation of female RCL(cm) and LCL(cm) r=0.605

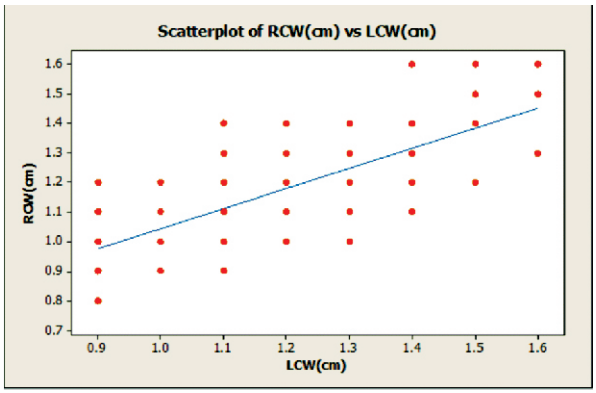

Figure 3. Pearson correlation of male Right mid shaft diameter (RCW) and left mid shaft diameter (LCW) = 0.723

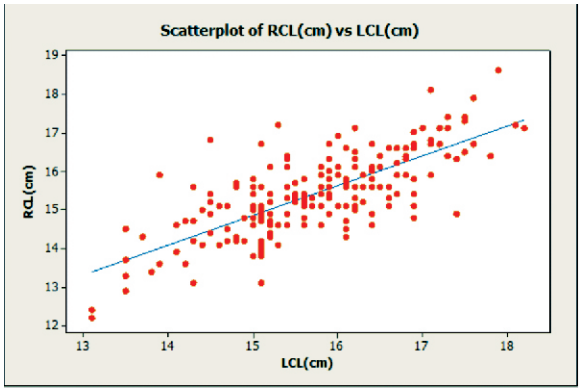

Figure 4: Pearson correlation of male RCL(cm) and LCL(cm) = 0.743

DISCUSSION

The clavicle is situated at the root of the neck and throughout its entire length lies just beneath the skin and can easily be palpated[2]. The clavicle is one of the most frequently broken bones in the body[6]. The fracture is always between the costoclavicular and coracoclavicular ligaments, each of which is stronger than the calvicle itself[7].

Radiologic Anatomy is the study of bodily structure using radiographs and other imaging methods[22]. Anthropometry is the external measurement and description of human body and its parts for the purpose of comparison and establishing norms for sex, age and race[23].There are biologically and statistically significant variations between human populations in body shape[24]. The accurate identification of sex and race remain pivotal in forensic science and physical anthropology, especially because of the escalating crime rates, which have become a worldwide phenomenon. The role of the skeleton in estimating attributes such as age sex, race and stature have been studied extensively and more so using radiographs [25]. The clavicle has been described as a useful bone for the determination of sex and age in a several populations[26,27,28], some of the authors used the discriminant function analysis to study sexual dimorphism (Frutos) while others used the demarking point analysis[21,18] . Chummy[7] stated that the clavicle is longer in the male than females. The mean clavicle length in males in the present study was longer in the males than the females. This also in line with the study carried out by other authors[11,12,13,14]. Terry[16] had noted that in male and female American Negroes and in male American whites, the left bone was longer than the right but not statistically significant. In the present study, it was observed that the left clavicle of the people in Rivers State was longer than that of the right clavicle. However, this was not statistically significant. The mean length of the clavicle in the present study is for males and females is higher than that of the Indians as carried out by[21] the female length of the clavicle in the present study is higher than that of the clavicular length of the French and English females in the research carried out by[12,17]. Our result for males was similar to that of the French and English males. The mid Shaft clavicular diameter has been worked on by[11] they observed that the males had a larger mid shaft diameter than the females. This is in line with the present study, as the males in this study had a larger mid shaft diameter than the females. It was also observed that the value of mid shaft diameter in the present study for males was lower than that of the males of Southern Nigerians[11]. When comparing the measured parameters in our study with research works done by previous authors, there were ethnic and racial differences.

These differences suggest that the length and mid length thickness of the clavicle may vary as a result of environmental differences within a population (e.g., socioeconomic status differences) or differing levels of modernization and social and economic development between nations. These are important source of variation in clavicular length, mid clavicular diameter and body proportions. In the study[29], logistic regression models were used to predict the sex of the specimens from the various morphometric parameters. The maximum length and mid-shaft circumference was highly significant in determining the sex of the clavicle. The logistic regression model showed an 89% accuracy in the prediction of the sex of the clavicle from the maximum length and mid-shaft circumference. A formula generated from their study for the prediction of the sex from the parameters of the clavicle.

In the present study, a correlation was carried out between both sides of the clavicle for males and females. It was observed that there was a strong positive correlation between right clavicular length and left clavicular length for females. This was also carried out for the right clavicular mid shaft diameter and left clavicular mid shaft diameter for males. It was observed that there was a strong positive correlation. A linear regression formulae for estimation of males and female clavicles of the Rivers people were established in the present study.

CONCLUSION

This research has provided a baseline data for the Clavicular length and mid Shaft diameter of the clavicle in Rivers state. It will be useful to the anatomist, radiologist, the surgeon, forensic scientist and biological anthropologist.

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